



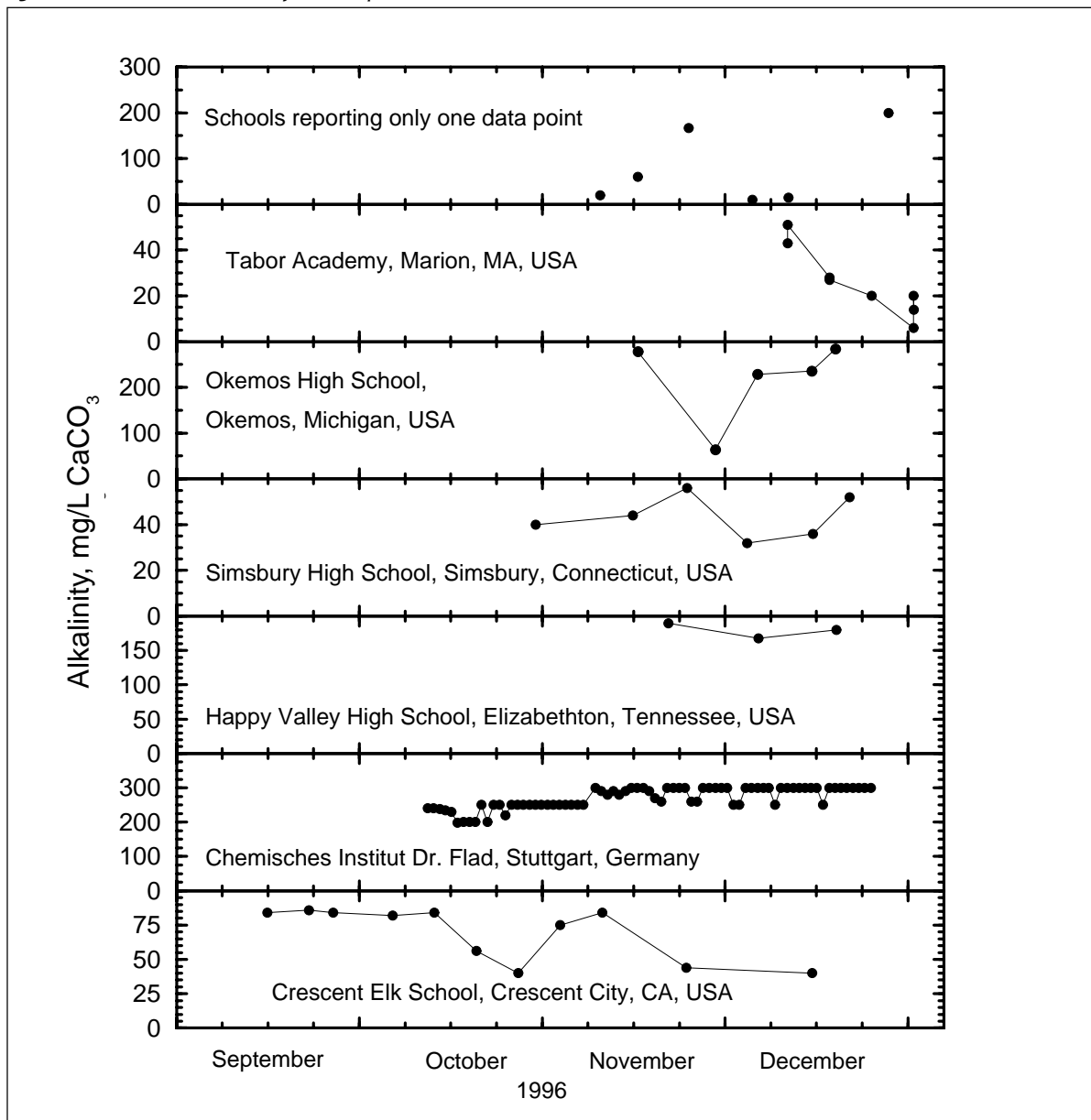
Section 2 - Analysis of New GLOBE Data

Alkalinity was added as a Hydrology protocol in September of 1996. These are a few findings from analysis of some of the earliest schools reporting these data.

1. Have students examine the data from the graphs. How do the data differ?
2. Have students pose questions generated from their observations. For example:

- What is the data trend? Would you expect it to change seasonally?
 - Do the data seem to be within a normal range?
 - Are there any unusual data points?
3. Have students predict further trends in the data sets.
 4. Record the observations, questions, and predictions.
 5. Have students devise ways to answer their questions.

Figure HYD-L-11: GLOBE Alkalinity Data, September-December 1996



Note from the scientists

Crescent City, CA, USA is reporting relatively low alkalinity values that exhibit quite a bit of variation with time. These changes could be associated with rainfall, which lowers alkalinity. It will be interesting to put these together with other GLOBE hydrology and atmosphere data for the site in order to gain a more complete picture.

Stuttgart, Germany has a very nice time series that captures even day-to-day changes in alkalinity. They see a slight increase in early November, but otherwise relatively steady values. These relatively high values are from a well-buffered surface water. Again, day-to-day changes could be associated with rainfall.

Elizabethton, TN, USA. Values are intermediate, between those for Crescent Elk School and Chemisches Institut, and are quite consistent with each other. We will be eager to see if alkalinity changes through the winter and into spring.

Simsbury, CT, USA is also reporting relatively low alkalinity values that exhibit some variation with time. In fact, it is surprising that the changes with time are so small, given the range reported. It will be interesting to see if values drop lower during rainfall or snowmelt.

Okemos, MI, USA is reporting alkalinity values that show an interesting drop from nearly 300 mg/L down to about 70 mg/L. We will need to put this together with the other GLOBE hydrology, soil and atmosphere data for the site in order to gain a more-complete picture of what happened.

Marion, MA, USA. Their values are very low and show a steady decline with time. We recommend that they double check their calculations, which if correct show a quite interesting pattern. Are we seeing the effects of tides at this coastal site?

Electrical Conductivity was added as a Hydrology protocol in September of 1996. These are a few findings from analysis of some of the earliest schools reporting these data.

1. Have students examine the data from the graphs. How do the data differ?
 - What is the range of the data within one site?

- What is the range of data encompassing all sites?
 - What are the data trends? Up? Down? Constant?
2. Have students pose questions generated from their observations.
 3. Have students predict further trends in the data sets.
 4. Record the observations, questions, and predictions.
 5. Have students devise ways to answer their questions by generating hypotheses and justify or support their hypotheses.

Note from the scientists

Belton, TX, USA reports two entries of conductivity measurements from their water site. Both are at very normal levels for a stream system (700 $\mu\text{S}/\text{cm}$, and 745 $\mu\text{S}/\text{cm}$) It will be interesting to see what data show up in the future!

Marion, MA, USA has discovered that their water site consists of relatively pure water with a fairly low conductivity range of 60 $\mu\text{S}/\text{cm}$ - 22 $\mu\text{S}/\text{cm}$ thus far. Compare these results to what Okemos High School reports and you'll see what a range of impurity levels natural water systems can have!

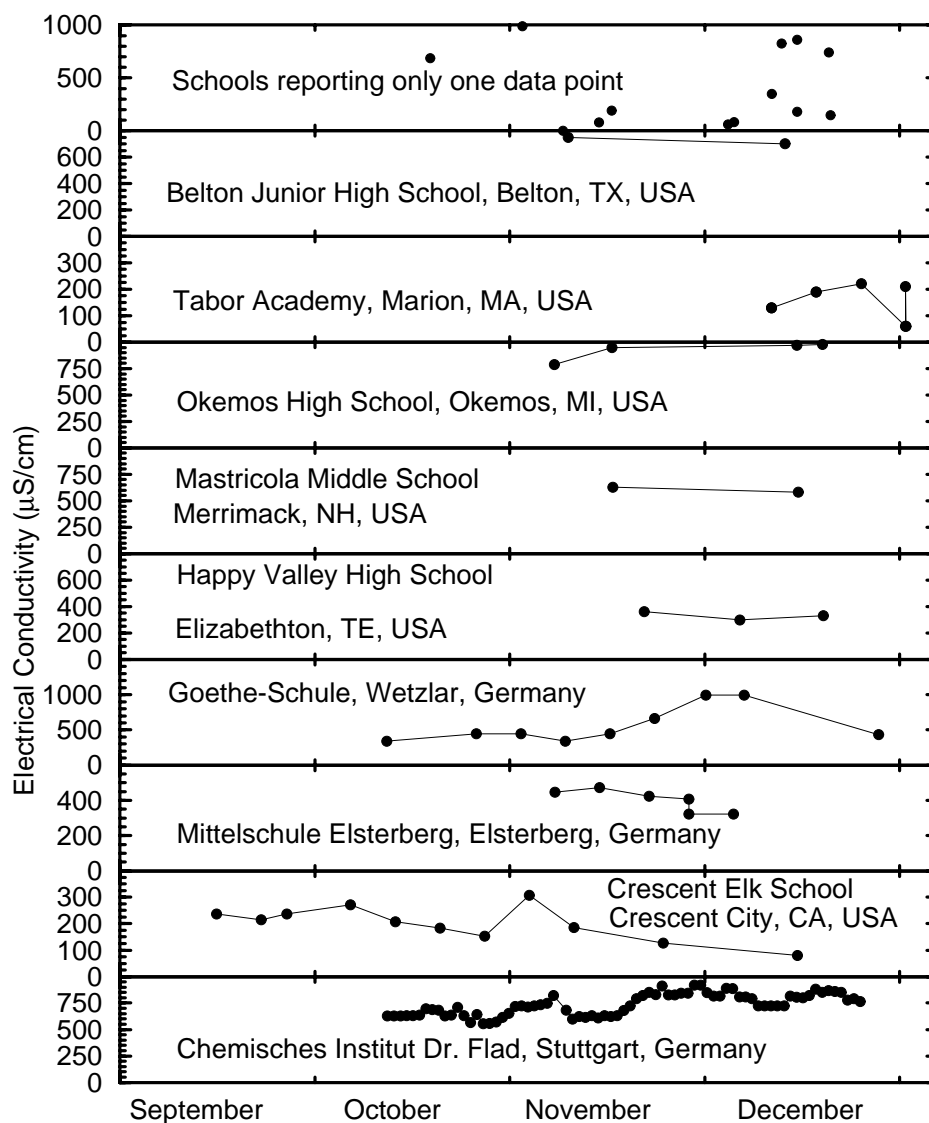
Okemos, MI, USA measured conductivity with a range of 790 $\mu\text{S}/\text{cm}$ - 980 $\mu\text{S}/\text{cm}$! This means that their water is fairly consistently full of dissolved chemicals.

Merrimack, NH, USA has reported 2 conductivity entries, 590 and 630 $\mu\text{S}/\text{cm}$. Look at the other graphs and see where this school falls relatively. What would this indicate about the water? Keep in mind that electrical conductivity is an indicator of what ions are dissolved in the water, and may thus describe the rocks through which the water has flowed.

Elizabethton, TN, USA measures their electrical conductivity in a water source with relatively consistent and low values of conductivity (range: 300 $\mu\text{S}/\text{cm}$ - 360 $\mu\text{S}/\text{cm}$) We encourage this school to continue reporting data so we know more about what the water is like in Tennessee and how it changes over the course of the year!



Figure HYD-L-12: GLOBE Electrical Conductivity Data, September-December 1996



Wetzlar, Germany shows the biggest range of measurements of any of the schools we looked at. (Range: 339 $\mu\text{S/cm}$ - 993 $\mu\text{S/cm}$) They are regularly reporting data every two weeks or so and have found an exciting trend at their site! Over the course of about a month, their conductivity measurements began to climb. What could have caused this change in water chemistry?

Elsterberg, Germany shows that their hydrology water system is fairly consistent in terms of the levels of impurities measured. Their conductivity measurements range from 322 $\mu\text{S/cm}$ to 472 $\mu\text{S/cm}$.

Over the course of their measurements, we see that there has been a slow decline in measured conductivity. What might be causing this?

Crescent City, CA, USA has been reporting data consistently over the 3 month period. Their conductivity measurements appear fairly low. We think we see a gently downsloping trend to the data. Do you? Compare the alkalinity trends and rainfall data to the electrical conductivity trends in Crescent City, USA. Do you see any patterns?

Stuttgart, Germany has developed a real reputation among the hydrology team for reporting many data points. Their conductivity measurements are no exception, and show that their water system changes not only over the course of the three month period of time, but also on a daily basis. Their data range all the way from 552 $\mu\text{S}/\text{cm}$ to 920 $\mu\text{S}/\text{cm}$. We think we see evidence for individual storm events in the data here, and possibly a seasonal trend in the levels of impurities. Do you agree? How do these trends compare to rainfall and alkalinity patterns?

Dissolved Oxygen was added as a Hydrology protocol in September of 1996. These are a few findings from analysis of some of the earliest schools reporting these data.

1. Have students examine the data from the graphs in Figure HYD-L-13.
 - How do the data differ?
 - What is the range at different sites?
 - What is the trend in the data?
 - Do all of the data seem to be within normal range? What other information should you consider when judging 'normal range' for dissolved oxygen?
2. Have students pose questions generated from their observations.
3. Have students predict further trends in the data sets.
4. Record the observations, questions, and predictions.
5. Have students devise ways to answer their questions.

Note from the scientists

Belton, TX, USA reported two data points at a level of 9 mg/L. This amount of dissolved oxygen suggests a healthy water source in which fish and plants can live. We encourage Belton to continue making dissolved oxygen measurements, to see how their levels change in the winter and spring.

Marion, MA, USA is measuring a water source where the dissolved oxygen levels are around 10 - 11 mg/L. This range of oxygen levels is supersaturated for a temperature range above 11° C at 0 m. elevation. At the same time that

Tabor recorded these DO measurements, they recorded temperatures in a range of 6-8° C. What could cause DO levels to get so high?

Simsbury, CT, USA Simsbury High School reports that their water showed levels of dissolved oxygen at 11 mg/L during October and a sharp rise to a level of 14 mg/L in mid-November. The dissolved oxygen measurements are very consistent until the last entry. We would very much like to know why the last entry is higher. Temperatures measured by Simsbury HS ranged from 1-9° C during this time. On a cautioning note, the recorded temperature when Simsbury HS measured 14 mg/L dissolved oxygen, was 3° C. This DO measurement is supersaturated for this temperature. This suggests that the calibration of Simsbury's dissolved oxygen kit may be off.

Okemos, MI, USA displays a surprising jump from 4 to 12 mg/L in their DO measurements. Once a careful calibration of equipment used for taking measurements has been done, we propose that if this trend is correct, it might reflect a combination of a drop in water temperature and a drop in the level of biological oxygen demand during the winter.

Merrimack, NH, USA shows a drop in DO from 9 to 7 mg/L over a month period of time, November - December. This drop may represent something interesting in this watershed and we think it is important for the school to think about what may be causing this drop.

Elizabethton, TN, USA measures in their water dissolved oxygen levels that range from 10 to 12 mg/L over a period of about a month. This may be the result of a decrease in water temperature or it may reflect something else. It will be interesting to compare water temperature records with these measurements.

Wetzlar, Germany reports two entries that indicate that their water site possesses fairly high levels of dissolved oxygen (13 mg/L). It is interesting to note that 13 mg/L DO at the temperature recorded, 3.8° C, is very near to saturated. This water source is probably actively mixed with the surrounding air.



Vinalhaven Island, ME, USA initially measured DO levels as high as 10 mg/L but then note a downward trend in their DO over the course of the next month and a half, when they measured it at 7 mg/L. What might cause this kind of drop in oxygen levels? Perhaps certain types of algae that produce oxygen during earlier times of the year begin to die off about this time, and cease to produce oxygen. Another possibility is that the DO level is coming back down from some episode that substantially increased the oxygen level.

Crescent City, CA, USA measures their data on a very regular basis and the data show the changes that take place in their site on a bi-weekly basis. Their oxygen levels gradually go up and down over a range of about 5 to 10 mg/L. It is interesting to note what appears to be an overall decline in dissolved oxygen levels during the 3 month time span shown. This would lead an observer to speculate that the DO levels are decreasing as water temperatures decrease. But does this make sense? Not really, since we would expect DO levels to increase with a decrease in water temperature since cold water can hold more dissolved oxygen than warm water. What might account for this trend? The DO trends follow the conductivity and alkalinity trends. As scientists, we would like to know information about what plant and rainfall activity has occurred over this time period, and about how water discharge levels have changed over this period of time.

Stuttgart, Germany shows the most frequent and consistent series of measurements of the GLOBE schools. They show that dissolved oxygen levels in their area fluctuate over a range of about 10 to 18 mg/L. While trying to figure out what might have produced such high DO measurements, the hydrology team realized that Stuttgart does not always record temperature measurements with their dissolved oxygen entries. Since DO is so temperature dependent, we strongly recommend that schools report water temperature if they measure dissolved oxygen.

Continuing Your Data Analysis

Read the data reports from the Hydrology Investigation on the GLOBE Student Server at the Scientist's Corner. These reports will be updated periodically.

Further Investigations

1. Encourage students to retrieve the current data sets for the schools above and graph the data using the GLOBE graphing tools or import the data into a spreadsheet to graph. What questions were answered by the longer term data set?
2. What questions require other data, such as temperatures or precipitation, to answer. Have students identify data which they think might be relevant and compare it with the Hydrology data. This might include:
 - Does examining soil characterization data help to explain conductivity?
 - What is the relationship between temperature and dissolved oxygen? Are other measurements correlated with temperature?
 - Do dissolved oxygen levels show seasonal fluctuations? What other data fluctuate seasonally?
 - Examine changes in pH at schools with differing levels of alkalinity. Do pH values fluctuate more at sites with high or low levels of alkalinity?
 - Graph precipitation for your site. What hydrology measures changed when you had heavy precipitation? Use the GLOBE contour or point maps to identify other areas showing heavy precipitation for a recent date. What happens to the water chemistry measurements at these sites after the rain?

Were further questions generated by the longer term of data collection? Record these questions and encourage students to come up with methodologies for further research.



Suggestions: Use the GLOBE maps to identify sites with similar latitudes for comparison. Identify 'control sites', or sites which are similar to the one you are investigating except for the variable you are interested in. For instance:



1. Use GLOBEMail to ask questions about site information not reported to the GLOBE data server and to share research with other schools.
2. Use the graphing capabilities of the GLOBE graphing tools to graph data from 2 schools for comparison
3. Use topographic maps to identify watersheds. Zoom into the region you identify in the GLOBE visualizations and find GLOBE sites contained in that watershed. Graph water chemistry data from sites within the watershed to try to identify changes along the course of the waterway.



As more data are added to the GLOBE Student Data Server, continue to identify schools which are of interest to you. Find schools in locations similar to your own. Are their hydrology data similar to yours?



Ask students to critically examine their own data using maps and graphs to look for patterns or unusual data. Ask questions, identify ways to explore their data for answers, and begin to explore their own site.



Student Assessment

Students should be able to identify trends, anomalies and problems with data sets. This capability can be demonstrated in class discussions and by providing them with examples of graphs and asking them to explain the trends, anomalies and issues which they come up with by analyzing the data as a written exercise. They should also be able to demonstrate an understanding of the limitation of what can be understood from a data set. They should be able to use the GLOBE graphing tools to create graphs and analyze data that they find and prepare. Through this activity the students should also gain an understanding of the GLOBE measurement parameters such as pH, temperature and alkalinity. The science content understanding can be assessed in the context of the assessment of the student's understanding of the science of data sets.

Macroinvertebrate Discovery



Welcome

Introduction

Protocols

Learning Activities

Appendix

Macroinvertebrate Discovery

Purpose

To determine the diversity of benthic (bottom dwelling) macroinvertebrates at your Hydrology Study Site and to investigate the correlations between macroinvertebrates and water chemistry measurements.

Overview

Students will establish a diversity index for benthic macroinvertebrates by sorting and counting organisms collected from the site, and in the process become familiar with many taxa of macroinvertebrates. They will then investigate the relationship between the taxa they found and their water chemistry measurements.

Time

One class period to do the practice exercise

One class period to collect sample and one class period to do the counts and calculate the index

Level

All

Key Concepts

- Species diversity is related to water chemistry
- Species have different habitat requirements
- Random sampling can be used to determine species diversity

Skills

- Calculating a diversity index
- Performing a random sample
- Building tools
- Identifying taxa
- Discovering species habitat parameters
- Taking water chemistry measurements

Materials and Tools

For Practice Activity

Shallow, white tray or pan (such as a styrofoam meat tray) - about 60 X 40 cm

Black marker

Ruler

Small candies, cake decoration confetti, or other items of varying colors or shapes to sample

Macroinvertebrate Work Sheet

Ice cube tray for sorting taxa

Small pieces of paper numbered from 1-50 for drawing random numbers

For Field Activity

Sorting and sampling kit (3 sets needed)

Shallow white pan for sorting, about 30 x 20 cm

Shallow white tray for counting, about 60 x 40 cm

Black permanent marker

Ice cube tray for sorting taxa

10-20 mL bulb basting syringe (end should be approximately 5 mm diameter)

Large plastic forceps

Magnifying glass

3 mL Pasteur pipette (eye dropper) (end should be approximately 2 mm diameter)

4-L sample container with lid (or 4 1-L containers)

Set of numbered tiles or paper

Bucket for pouring water through net

Additional containers with lids if macroinvertebrates are to be brought back to the classroom

Macroinvertebrate Work Sheet